# Space Weather Technical Forecast

Issued on Sunday, 14 January 2024 at 01:28 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Chance of M-class flares throughout.**
**Analysis of Space Weather Activity over past 24 hours**
**Solar Activity:** Solar activity is at Low levels, with background irradiance also at C-class levels. The largest flare of the period was a C2.7 peaking at 12/0421 UTC, attributed to Ex-AR3538 beyond the northwestern limb. There are currently fifteen sunspot regions, well distributed across the visible disc. Over the past 24 hours one small Bxo region has developed in the northeast, and a more complex region is emerging from across the eastern limb. The most complex region appears to be AR3541 (Eai/Beta-Delta) in the southwest, which is part of a larger complex of sunspots. There is evidence of magnetic looping on coronagraph imagery which may result in greater instability than the raw probabilities suggest. There appears to be a weak delta spot on the large spot in the trailing portion of AR3541, although this is a marginal feature. Despite the large number of spots, none appear to be significantly complex at the present time, with the exception of AR3541.

No CMEs observable on coronagraph imagery over the past 24 hours are expected to have an Earth-directed component.

**Solar Wind / Geomagnetic Activity:** Solar winds, as observed by DSCOVR at L1 have remained close to Elevated levels, throughout and have gradually declined from 500 km/s to 470 km/s. Between 13/1500-2300 UTC the wind trace became degraded, suggesting speeds closer to 400 km/s. However, ACE has not been tracking since 11 Jan so a comparison was not possible. Density has been largely average, although the trace appeared similarly erratic 13/1500-2300 UTC with below average values observed. The interplanetary magnetic field (IMF), Bt, has been weak throughout, at or below 5nT. The north-south component, Bz, fluctuated weakly. Phi angle has been positive throughout.

Geomagnetic activity was Quiet (Kp 0-1).

**Energetic Particles / Solar Radiation:** GOES18 high energy (greater than 10MeV) proton flux was at background levels.

GOES16 high energy (greater than 2MeV) electron flux was at background to moderate levels. The associated 24-hour fluence was well below Active (1e8 integrated pfu) throughout. The 13/0000 UTC 24-hour integrated fluence observation was 3.00e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**
**Solar Activity:** There is a chance of isolated M-class activity throughout, and a slight chance of X-class flares. The flare risk declines slightly with the departure of AR3539 on Day 1 (14 Jan). A number of regions are due to return to or rotate onto the disc during the period, with an increase in flare risk once more by Day 4 (17 Jan).

**Solar Wind / Geomagnetic Activity:** No Earth-directed CMEs currently feature in the forecast. Wind speeds are expected to remain at similar levels, perhaps declining through Days 1-2 (14-15 Jan). The main feature of interest is CH92/+, currently centre disc in the northern hemisphere. Wind speeds of 450-500 km/s, with an arrival time late Day 3 (16 Jan) or into Day 4

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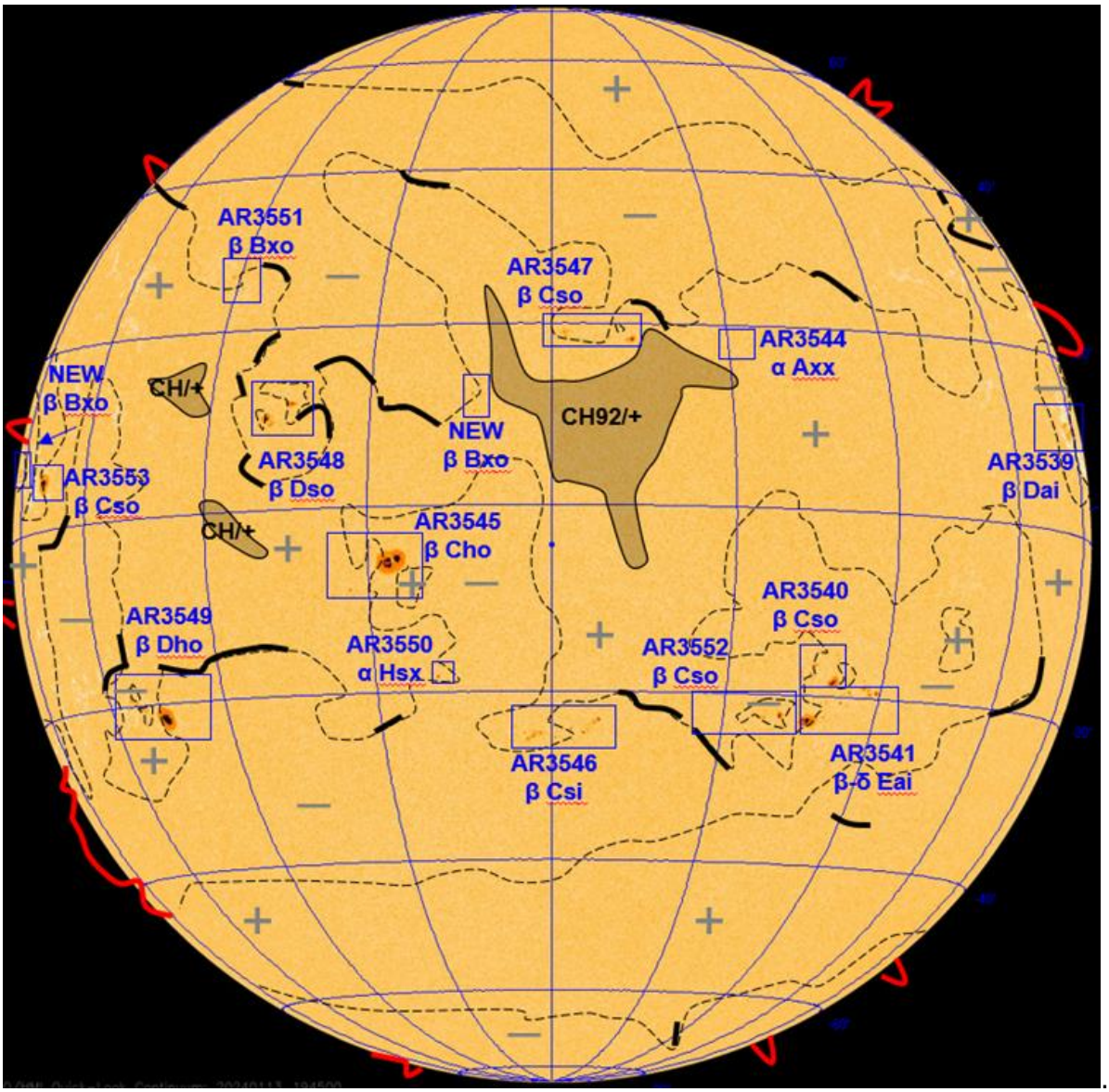
(17 Jan) are expected upon connection to the HSS.

Overall, geomagnetic activity is likely to be Quiet (Kp 0-2) throughout, but with a chance of Unsettled to Active (Kp 3-4) intervals on Day 4 should we see any HSS influence.

**Energetic Particles / Solar Radiation:** High energy proton flux will most likely remain at background levels. Although, there remains an ongoing slight chance of seeing an increase to the S1/Minor Radiation Storm threshold, should any notable flares occur.

The high energy electron flux is forecast to persist at background levels, with fluence below Active through this period. There is a chance of slight enhancement from late Day 3 (16 Jan) or more likely Day 4 (17 Jan).

**Figure 1. Solar Analysis Valid 13/2000 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast.

Wind speeds are currently around 450-480 km/s, and are expected to decline towards 400 km/s or ambient levels Days 1-2 (14-15 Jan). The main feature of interest in the forecast period is CH92/+, currently centre disc in the northern hemisphere. This coronal hole is a persistent feature, but is much smaller and fainter than on the previous rotation, with the leading edge further back than last time around. Wind speeds in the High Speed Stream (HSS) reached above 600 km/s on the previous rotation, on the equivalent of Day 2 (15 Jan). However, the much reduced size of the coronal hole suggests slower wind speeds of 450-500 km/s, which combined with the change in location, gives a potential arrival time later Day 3 (16 Jan) or perhaps into Day 4 (17 Jan).

Recent Enlil runs support the idea of slight wind enhancement 16-18 Jan, with speeds of 400-450 km/s, largely representative of what is expected.

Overall, geomagnetic activity is likely to be largely Quiet (Kp 0-2), especially Days 1-2 (14-15 Jan). There is a chance of Unsettled to Active (Kp 3-4) intervals from later Day 3 (16 Jan) upon connection to the anticipated coronal hole HSS.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 1 | 5 | 5 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMEs feature in the current forecsat.

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**Figure 2: MOSWOC Enlil showing slight enhancement in winds later in period.**

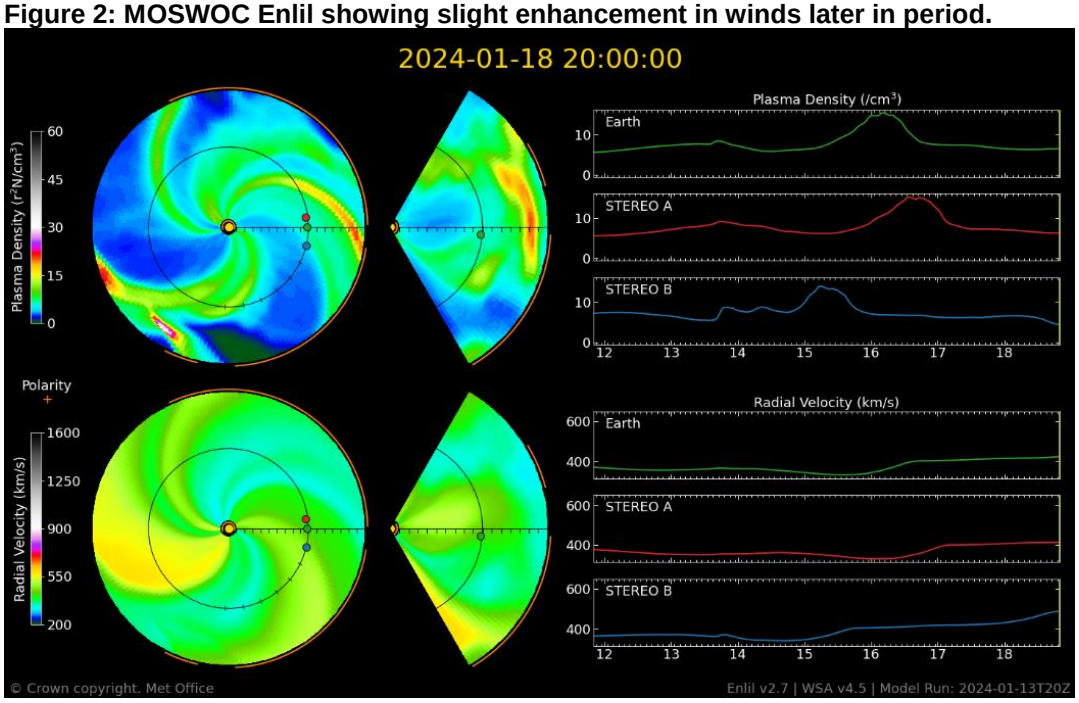
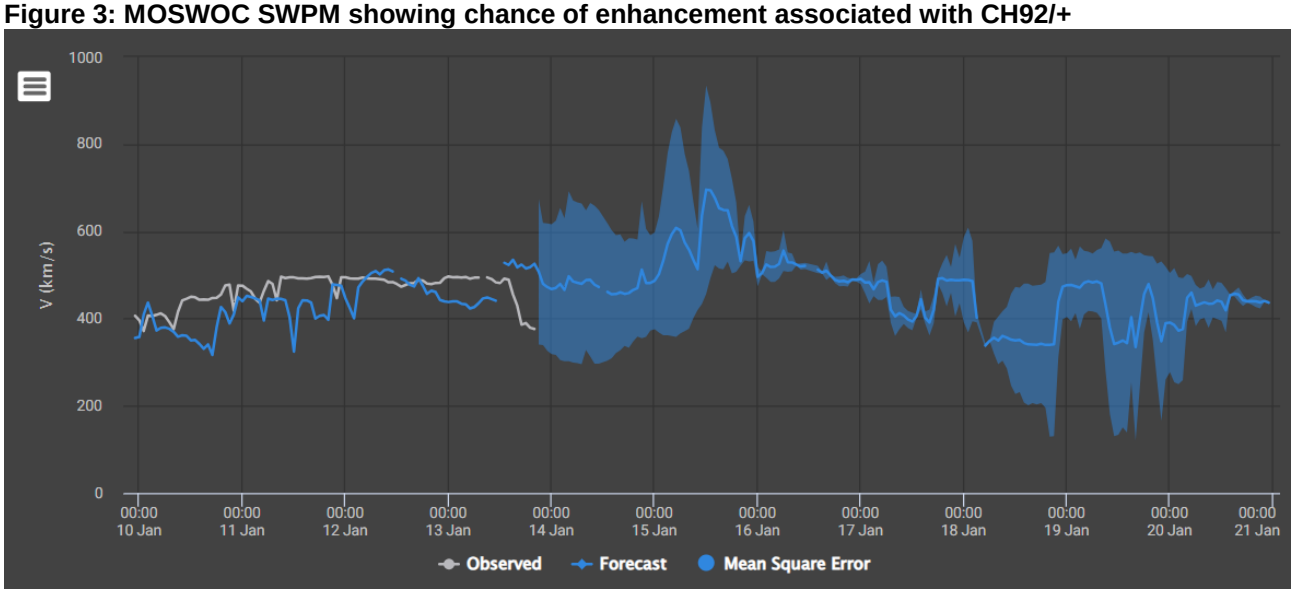



**Figure 3: MOSWOC SWPM showing chance of enhancement associated with CH92/+**

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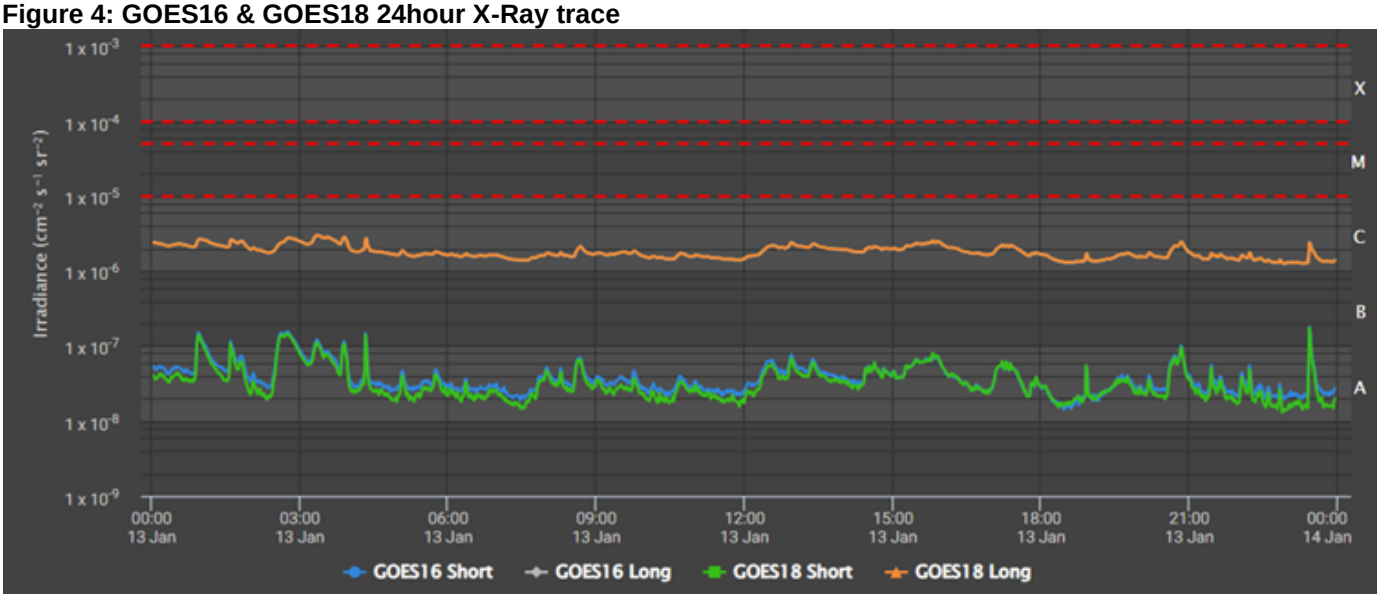
**Radio Blackouts - X-Ray Flares:**
Solar activity is at Low levels. The largest flare of the period was a C2.7 peaking at 12/0421 UTC, attributed to Ex-AR3538 situated beyond the northwestern limb.

There are thirteen numbered and two unnumbered sunspot regions currently on the disc. The most complex region appears to be AR3541 in the southwest, which is set amongst a larger complex of sunspots. There is evidence of magnetic looping on coronagraph imagery which may result in greater instability than the raw probabilities suggest. AR3549 in the southeast remains the largest of the groups, and has recently shown some signs of increased activity. The other regions do not appear to be significantly complex at the present time.

Seismic analysis and recurrence would suggest that there are a number of regions which are due to return or rotate across the eastern limb through the period. This is supported by areas of brightness visible on EUVI/AIA 195 imagery suggesting the proximity of Carrington regions.
There is a chance of isolated M-flares throughout, with a slight chance of X-flares, perhaps most probable from the AR3541 region or AR3539 which is due to rotate off the disc during Day 1 (14 Jan). There is an associated slight reduction in probabilities at this point, with an increase on Day 4 (17 Jan) by which point a number of regions are expected to have rotated fully onto the disc.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 50 | 40 | 40 | 50 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

**Figure 4: GOES16 & GOES18 24hour X-Ray trace**

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## Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently at background levels. Any further notable flares will bring a risk of proton flux rising, especially if they occur close to the western limb. Overall, there is a continuing slight chance of reaching the S1/Minor Radiation Storm threshold. With the probability maintained as a number of regions depart, whilst others rotate onto or across the visible disc.

Please note: GOES18 is currently being used as the primary proton instrument, with GOES16 data currently viewed as unreliable due to a fault reported by NOAA.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ S1 | No | 5 | 5 | 5 | 5 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as measured by GOES16 at GEO is currently at background levels, and in the absence of any significant enhancement is expected to persist at this level throughout much of the forecast period.

Connection to a coronal hole high speed stream may occur from late Day 3 or Day 4 (16-17 Jan), persisting until the end of the period, although any associated enhancement is not expected to produce any significant electron response until Day 4 at the earliest.

MOSWOC REFM forecast values maintains fluence well below Active throughout the period, although the signal for a slight increase into Day 4. This is considered good guidance. Recurrence would suggest fluence values may approach the Active level by the end of Day 4 (17 Jan), however, the coronal hole is smaller and less pronounced on this rotation so any enhancement is expected to be less significant than on the previous rotation.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 1 | 1 | 3 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

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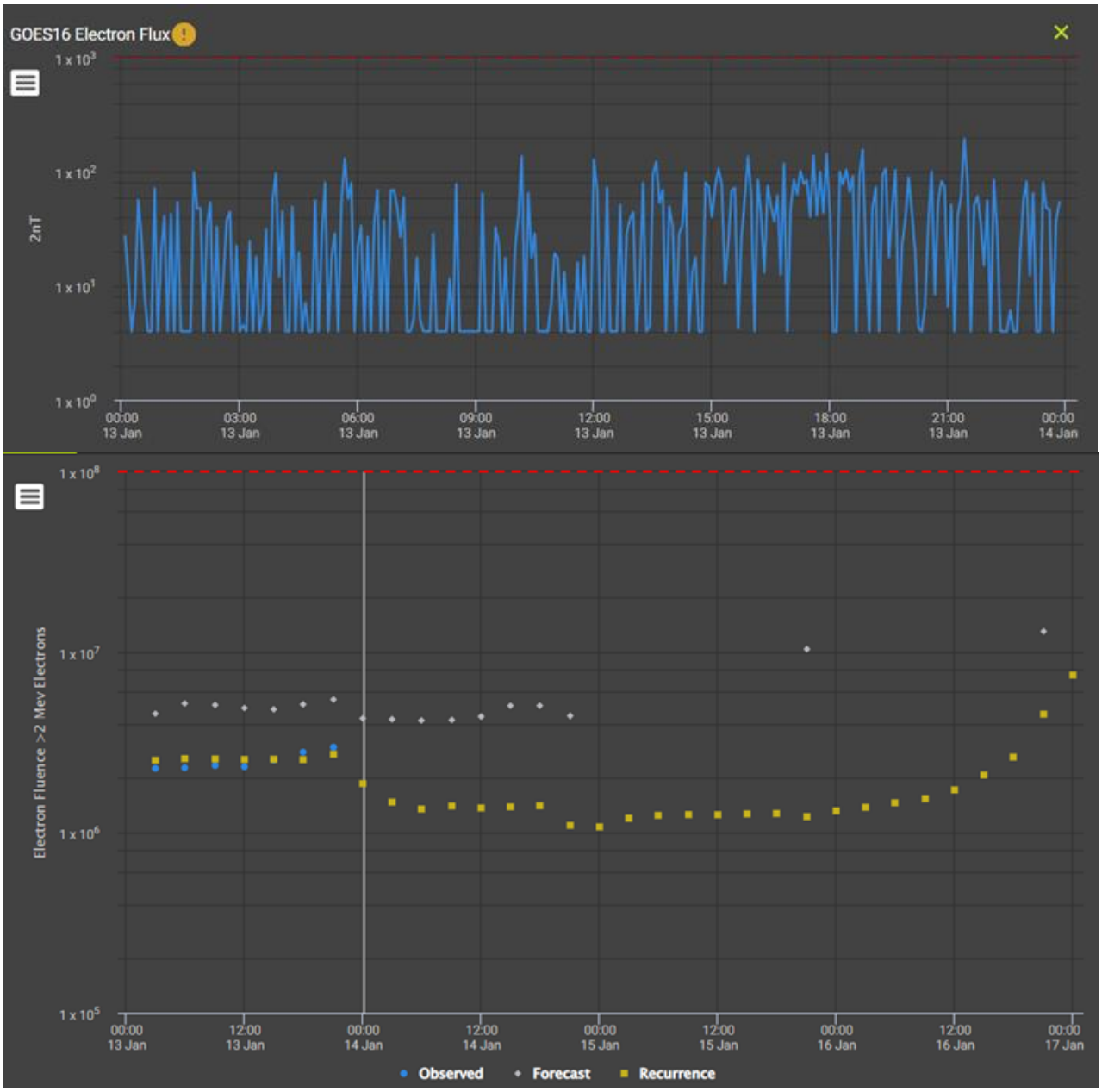
**Figure 5: GOES16 Electron Flux and MOSWOC REFM, giving reasonable guidance**

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